Criteria for a transparent assessment of carbon footprints in the food supply chain.

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Abstract

Our daily consumption patterns have a major influence on climate change. Several European initiatives use CO_2-labels for products to provide guidance for climate friendly consumption decisions. Different methodological details affect the total amount of greenhouse gas emissions (CO_2e) being labeled. A standardized method is needed to generate comparable results. The objective of this study conducted at the Institute for Marketing and Innovation of the University of Natural Resources and Life Sciences, Vienna, was to identify the key methodological criteria for transparent assessment of the carbon footprint of food products. Expert interviews and content analyses were the methodological approach applied. Current carbon footprint standardization processes have to meet the challenge of meeting both scientific accuracy and practicability in order to enable comprehensive implementation in management practice.

Keywords: carbon footprint, food, climate change, sustainability, content analysis

1. Theoretical background

Climate change is one of the major challenges of the 21st century. Producers, wholesalers, retailers and consumers face the responsibility to reduce greenhouse gas emissions. Consumers could have a major influence on climate change by changing their food consumption habits. Greenhouse gas (GHG) emissions due to food consumption are estimated to contribute 16% of the total GHG emissions of the private consumption (Fritsche et al., 2007). But therefore consumers would need a reliable indicator on the greenhouse gas emissions of food products. The integration of sustainability indicators like the carbon footprint (CF), which are in general non-monetary indicators, into the performance measurement system of companies is an important step to improve the sustainability of companies.

This paper focuses on the assessment of product CF. There are various definitions of CF. We use the following as working definition in accordance with Wiedmann and Minx (2007, 4): In general the CF can be assessed for „activities of individuals, populations, governments, companies, organisations, processes, industry sectors etc. Products include goods and services. In any case, all direct (on‐ site, internal) and indirect emissions (off‐ site, external, embodied, upstream, downstream) need to be taken into account" (Wiedmann and Minx, 2007, 4). The *product* CF is an environmental input/output-related indicator to measure direct and indirect greenhouse gas emissions along the product life cycle. CF can be used for climate-friendly production or for communication purposes to consumers (Frey and Mühlbach, 2009). It is important to note, that product CFs do not measure other economic, social, or environmental impacts, such as biodiversity, labor standards, toxicity or water footprints. Overall the unit of the carbon footprint is measured in grams of CO_2-equivalents (CO_2e). It is applied to support climate friendly production and to help consumers in making informed purchase decisions.

International and national initiative recognized the need for a European or even world wide accepted standard to assess the CF on the product level. Based on ISO standards 14040/44 there are several standards available or under development (see Table 1).

Table 1: International standards

ISO 14040/44		
ISO 14 067	WRI/WBCSD	PAS 2050
Carbon footprint of Products	GHG protocol product accounting and reporting standards	Specification for the assessment of the life cycle of goods and services
[2011]	[2011]	[2008]

Source: PCF Pilotprojekt Deutschland (2009)

However, there is no European widely accepted and unified assessment method to measure the climate impact of products (goods and services). Grieshammer (2008) estimated that worldwide 400 different climate related labels are on the market. The number of differing standards irritates consumers significantly and reduces the credibility of every single standard (PCF Pilotprojekt Deutschland, 2008).

Several European initiatives use CO_2-labels for products to provide guidance for climate friendly consumption decisions (e.g. carbon reduction label, "L'Indice Carbone", or "Zurück zum Ursprung"). These initiatives are applying different approaches to estimate product carbon footprints. Furthermore, a lack of transparency of the different approaches hinders their comparability. Differing methodological approaches often result in deviating total amounts of greenhouse gas emissions (CO_2e) for the same product, e.g. for 1 l of milk. Obviously the credibility of the indicator is threatened, if differing carbon footprints for products without any real differences in the production methods are communicated to consumers.

For carbon footprinting there are bottom-up (process based) life cycle analyses (LCA) and top-down approaches, based on environmental input-output analyses. The bottom-up approach has its strengths for assessing products but shows weaknesses in assessing environmental impacts at macro levels such as sectors or countries. The most common problem for bottom-up LCAs is the correct setting of system boundaries. A classical problem is the double counting of emissions. On the meso or macro level environmental input-output analysis, the top-down approach, should be applied when assessing environmental impacts. Its capability to assess products or processes is limited. The optimum solution would be a hybrid environmental input-output LCA, combining a process based LCA with input-output tables (Wiedmann and Minx, 2007, 6).

The two ISO standards 14040/44 provide the frame for all initiatives working on the refinement and definition of standards for product CFs. In brief, the ISO standards deliver a framework for environmental life cycle assessments containing general recommendation for ecological product life cycle analyses (from raw products to recycling). Per definition a life cycle analysis, which focuses only on green house gas emissions like a CF life cycle analysis (LCA) constitutes a simplified LCA. Several methodological criteria for the calculation of product related greenhouse gas emission equivalents could be extracted out of these ISO regulations 14040/44, like relevance, completeness, consistency, accuracy and transparency. Furthermore, it contains general regulations for the definition of functional units and system boundaries and general considerations and regulation concerning data quality. Despite the fact that ISO regulations 14040/44 advise to include the whole value chain ("cradle-to-grave"), it allows under monetary and time constraints or in case of restrictions concerning the availability of data, to define deviant system boundaries. But the ISO standards 14040/44 are not specifically defined for (product) CF assessments, which can be seen for e.g. in a lack of guidelines concerning GHG emissions. Due to this reason the ISO standard 14067 for product CF assessments is under development.

CF standards should integrate all greenhouse gas emissions which are considered by the Intergovernmental Panel on Climate Change (IPCC) into the calculation of a global warming potential (CO_2, CH_4, N_2O, all kinds of fluorinated hydrocarbons [like tetra fluorine ethane], sulfur hexafluoride, etc.; IPCC, 2006). In general, the greenhouse gas emissions are transformed into CO_2-equivalents (CO_2e), the analytical time frame corresponds to 100 years. Both, biogenic and fossil emission sources are relevant for the calculation of product related greenhouse gas indicators.

At the time of this study most carbon footprint analyses were oriented at two guidelines: ISO 14040/44 and Publicly Available Specification 2050 (PAS 2050). While ISO norms define the general framework for life cycle assessments, the PAS 2050 contains specific criteria for the assessment of product related carbon footprints. In 2007 the British Standard Institute together with the department of Environment, Food and Rural Affairs

(DEFRA) and Carbon Trust started an initiative to develop a product oriented carbon food print indicator, the PAS 2050. It was first published in October 2008 and became the first standard for a product specific carbon footprint (BSI British Standards, 2008).
PAS 2050 is based on the life cycle assessment methods established through ISO 14040 and ISO 14044 by specifying requirements for the assessment of the life cycle of greenhouse gas emissions of products and services. It is a bottom-up process life cycle assessment and distinguishes between business-to-business (B2B) cases ("cradle-to-gate") and business-to-consumer (B2C) cases ("cradle-to-grave"; see Figure 1).

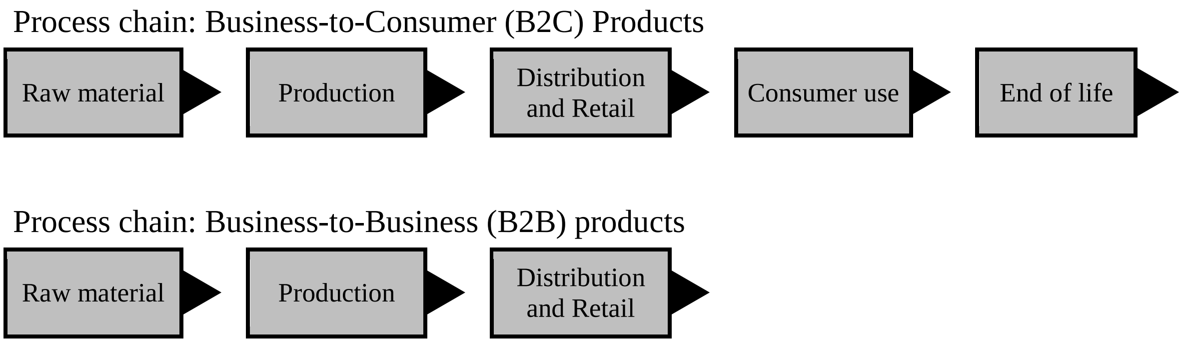

Fig. 1: Process steps in product PAS life cycles analyses (B2B and B2C)
Source: BSI British Standards (2008)

The World Business Council for Sustainable Development (WBCSD) and the World Resources Institute (WRI) developed the Greenhouse Gas Protocol (GHG Protocol, see table 1), which is scientifically and internationally accepted and applied (WRI/WBCSD, 2009). The GHG Protocol is a standard for reporting GHG caused by an organization and consists of two parts: the Corporate Accounting and Reporting Standards (Corporate Standard) and the Project Accounting Protocol and Guidelines (WRI/WBCSD, 2009).
The GHG protocol distinguishes between three levels of GHG sources: scope 1, scope 2 and scope 3. Scope 1 encompasses all direct GHG emissions, coming from sources which are controlled or possessed by the company itself, for e.g. usage of fuel for chemical processes (Carbon Trust, 2009). Scope 2 relates to all indirect emissions, which derive from purchased electricity, warmth or steam. Scope 3 comprises under „other indirect emissions" all GHG emissions, which are related to company activities but the source of emission is not under direct control or influence of the company, such as business travels, waste management or the production of purchased product inputs (Carbon Trust, 2009). In November 2010 WRI/WBCSD released the second drafts of two new GHG Protocol standards:

- The Corporate Value Chain (Scope 3) Accounting & Reporting Standard
- The Product Accounting & Reporting Standard

The GHG „Corporate Value Chain (Scope 3) Accounting & Reporting Standard represents a forthcoming standard to assess GHG emission along the complete life cycle of a product. Unfortunately at the time when the interviews were made for this study the second draft of WRI/WBCSD consortium for product CF assessment was not released.
Nevertheless standardization and homogenization of the differing approaches is needed to generate comparable results. Ongoing international stakeholder processes initiated by ISO, British Standards Institute (BSI) and World Resources Institute and World Business Council for Sustainable Development (WRI/WBCSD) emphasize the increased focus on this topic. Current carbon footprint standardization processes have to meet the challenge of meeting both scientific accuracy and practicability in order to enable comprehensive implementation in management practice.

2. Methodology

The objective of this study conducted at the Institute for Marketing & Innovation (University of Natural Resources and Life Sciences, Vienna) is to identify key methodological criteria for a transparent and holistic assessment of the carbon footprint for food products. The applied literature analysis encompassed major standards for carbon footprints, e.g. ISO 14040/44, PAS 2050 and GHG Protocol WRI/WBCSD. Furthermore the study analyzed European initiatives already applying the carbon footprint such as "der Blaue Engel", "Stop-Climate-Change" or "l'indice Carbone". A content analysis of interviews with national and international experts

was applied to identify key methodological criteria for a future standardized assessment of the carbon footprint for food products. The general aim of a qualitative research approach is the understanding and reconstruction of perspectives of relevant actors (Bortz and Döring, 2006). Through expert interviews, highly aggregated and up until now not published expert knowledge becomes accessible. A literature review of European CF initiatives served to analyze their aims, stakeholders and applied methods (or CF calculations at the development stage). The results of the literature review were used to structure the interview questionnaire for the experts. Ten carbon footprint experts were interviewed during July and September 2009.
The experts evaluated the topic from a scientific theoretical perspective and from a user perspective as well, illustrating their experience with many case study examples. In average an interview took 40 minutes. Afterwards the interviews were summarized and analyzed following the guidelines of Mayring (2004, 2007) for qualitative content analysis. By summarizing, explicating and structuring of communication contents, conclusions could be drawn. The application of the software Atlas-Ti forced an inductive categorization and helped in re-shaping, defining and summarizing subcategories, resulting in an abstract structure.

3. Results

At the time of interviewing the experts there were two methodological standards available to estimate product related GHG emissions: ISO norm 14040/44 of the International Standardization Organization and the PAS 2050 of the British Standards Institution (BSI, 2008). In Austria, where most of the interviewed experts are located, the so-called ÖNORM regulations cover comparable regulations (ÖNORM, 2005a and 2005b); in other countries, similar regulations are available. However, taken the means and opinions of all interviewed experts (in total, the qualitative sample consists of 8 national and international experts), the actual regulations are not appropriate to guarantee comparable carbon footprint analyses (Burger et al., 2010). In total, the criteria listed in Table 2 should be defined in detail for carbon footprint (CF) analysis to provide valid and transparent results. Out of these criteria, mainly two attributes seem to be of major relevance: (1) system boundaries of product life cycle and (2) comparability. System boundaries are defined as a “set of criteria specifying which unit processes are part of a product system” (BSI British Standards, 2008).

3.1 System boundaries of product life cycle and comparability

The definition of system boundaries for CF assessment determines the lifecycle phases, geographical borders (regional validity), time horizons, and flows of material and energy. These attributes influence significantly the extent, validity, and comparability of CF calculations. Based on the experts’ opinions, a comprehensive and complete CF assessment for food should encompass system boundaries and functional units; it should name the included greenhouse gases, reveal the sources of data, and describe the rules how recycle- and by-products have been allocated. The explicit definition of the system boundaries of the product life cycle influences the metric size of CO_2e seriously: For example, if CF assessments cover the whole value chain from “cradle-to-grave” including recycling of waste, the reported CO_2e will be higher compared to “cradle-to-gate” assessments covering CO_2e until the shelf of the retail sector (however, calculations covering all stages of the product life cycle are of increasing complexity).

Table 2: Codes and frequencies of the code family „methodological criteria“

Methodological criteria	Code	Frequency analysis
System boundaries of product life cycle	MetKrit-SG	30
Comparability	MetKrit-Vergl	29
Functional unit / object of analysis	MetKrit-FE	12
Practicability	MetKrit-Prakt	12
GHG emissions	MetKrit-THG	10
The whole value chain	MetKrit-gesWK	8
Criteria specific for the product group	MetKrit-PCR	8
In conformity with targets	MetKrit-Ziel	8
Focus on main input factors	MetKrit-Stell	7

Sources of data and quality of data	MetKrit-DQ	7
General methodical requirements	MetKrit-Allgem	6
Transparency	MetKrit-Trans	4

Source: Burger et al., 2010, 105

The largest differences between available CF standards are due to different system boundaries definitions and to the selection and inclusion/exclusion of specific procedural stages within product life cycles. In PAS 2050 for example, GHG emissions from human labor, the commuting activities of the employees and the last mile to the consumer are excluded. Also GHG emissions necessary to build company infrastructure are excluded, GHG emitted for maintenance of infrastructure are included. In general, ISO 14040/44 recommends including the complete value chain, from raw material to recycling processes. However, there are huge differences between actual CF calculations and the related individual standards due to restrictions like data availability, time and budget restrictions, etc. Unequal analytical CF results are in particular problematic if companies use them for communication purposes (e.g., CF labels on food products). In that case end users will not be able to understand the background and restrictions of individual CF assessments. Confirming the interviewed experts, there is a need for comparable calculation schemes, which can be uniformly applied for CF calculations as PAS 2050 and ISO 14040/44 cannot guarantee the comparability of product CF assessments.
One approach, which is beneficial are so-called Product Category Rules (PCR). These rules refer to individual, product related specifics within a particular value chain and product category (differences between specific food categories). They constitute "requirements and guidelines for developing environmental declarations for one or more groups of products that can fulfill equivalent functions. PCRs offer a consistent, internationally-accepted approach to defining a product's life cycle. They are emerging but still cover a limited number of products. To check whether the product being footprinted is covered by a PCR, refer to the PCR section of www.environdec.com" (BSI British Standards, 2008).

3.2 Functional units and emissions of greenhouse gas

The selection of functional units should be mainly focused on the end users' demand, e.g. CO_2e related to 1 kg of product or 1 meal.
The metric calculation of CO_2e is based on the pre-selection of an appropriate greenhouse gas emission model. The emissions of greenhouse gas encompass specific greenhouse gases and the corresponding global warming potential, which is influenced by the timeframe of analysis. In agricultural production carbon dioxide, methane and nitrous oxides are important GHG. Furthermore emissions from land use and land use change (LULUC) should be considered. For example, emissions from soil are excluded in PAS 2050, because of inconsistent scientific knowledge about the influence of different tillage techniques.

3.3 Practicability and focus on most important input factors

Besides these criteria, which are already considered in existing standards, this study identified additionally the criteria „practicability" and „focus on most important input factors". These factors reflect the fact that the interviewed experts were practitioners expressing their experience that standards make only sense if you can implement them in an efficient and practical way. The experts mentioned that a CF standard should represent a balance between practicability and a focus on factors, which significantly contribute to the product CF.

3.4 Other relevant criteria

The quality of the used data influences the quality of a product CF analysis. PAS 2050 and ISO 14040/44 contain comprehensive guidelines about the quality of the data. It is important to document the sources of the used primary and secondary data. The availability and quality of primary data depends on the priorities of the involved companies and their market power. The compliance of general methodological requirements – consistency, relevance, completeness, accuracy, and transparency – is a prerequisite for a methodical correct assessment of product CFs. Concerning transparency it is important to document system boundaries, main assumptions, data sources, data quality, and rules for allocation of recycle- and by-products in a comprehensible way.

For communication purposes transparency is an indispensable necessity to prevent misinterpretations and to strengthen the credibility of the labeling initiative. For example, due to insufficient transparency about the system boundaries the French initiative L'indice Carbon got criticized, because the public believed that the consumer use-phase was included in the standard.

4. Discussion and outlook

In the previous interpretation the core results of the qualitative interviews have been compared with existing criteria of the ISO 14040/44 and PAS 2050 standards (for all results of the study address to Burger et al., 2010). ISO 14040/44 constitutes a good general framework for CF analyses and contains essential criteria, such as system boundaries for the product life cycle and detailed rules about data quality and allocation of recycle- and by-products. Though these ISO standards are not specific for assessments of CFs. Experts criticized the multitude of possible interpretations, which weaken the comparability of the assessed results. PAS 2050 is a standard already specific developed for product CFs, visible in extended guidelines for GHG models and emission sources. Experts mentioned that some of the methodical assumptions of PAS 2050 are normatively influenced. Before those normative judgments are incorporated into the standard, they should be part of a broad stakeholder discussion (Burger et al., 2010). Furthermore experts emphasized that existing CF standards are not appropriate for a fair product comparison. However, by publishing product CFs (even based on different standards) the comparability of these standards is implicitly assumed by end-users.

None of the existing standards contains the criteria "practicability" and "focus on main input factors". They should be considered for the ongoing discussion and further development of new standards. The core challenge for any standard is to be generally valid without becoming too unspecific. The best possible specification of any criterion is dependent on the objectives and the functional unit of the assessment. As long as there is no specific functional unit determined, the definition and description of methodical criteria has to be formulated in an abstract and global way, at least to be applicable for all possible cases.

Product Category Rules offer specific guidelines how to apply criteria for the assessment but still leave the question on the necessary degree of differentiation unanswered. To distinguish between plant and animal products makes as much sense as to distinguish between meat and milk products. But is it necessary to differentiate between frozen ground meat and fresh beefsteak? Fine-tuning beyond necessity could hinder practicability and the rate of implementation of CF standards. The measurement of GHG emission over the whole product life cycle and the information of consumers represent the main pillars for climate-save production and consumption.

Overall, the communication objectives influence the selection of methodical criteria for the CF assessment more then expected. Especially if product CF assessments are used for public relations, limitations of CF indicators become visible.

The interviewed experts of this study emphasized that it is not possible to make reliable conclusions about sustainability effects of products only based on CF assessments. Other indicators (water footprint, social welfare criteria, etc.) should be considered to evaluate the sustainability of products.

Despite the fact that there is room for improvement of the evaluated CF standards, up until now product CFs are a practical management-tool to measure and reduce GHG emission along the food value chain. Companies which already assess product CFs collect valuable first hands-on experience and will gain a competitive advantage for a climate-aware future in the agri-business sector. This conclusion is in accordance with the state of the art of CF research: "Companies with the technology and vision to provide products and services that address climate and other pressing issues will enjoy a competitive advantage" (Lash and Wellington, 2007, 10).

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